

DOCUMENTED BRIEFING

RAND

*Improving Training at
School and Work*

*Lessons from RAND Research on
Army Individual Training*

John D. Winkler

Arroyo Center

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John D. Winkler

DB-144-A

*Prepared for the
United States Army*

Arroyo Center

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PREFACE

This document summarizes results and insights from a number of RAND studies that assessed alternative strategies for making Army individual training more efficient and affordable. Although the studies focus on resident training conducted in U.S. Army schools, many of the insights that emerged also apply to civilian education and training.

The following publications were drawn upon in this document:

R-3848-FMP, *Effectiveness of Interactive Videodisc in Army Communications Training*, John D. Winkler and J. Michael Polich, 1990.

R-4228-A, *Linking Future Training Concepts to Army Individual Training Programs*, John D. Winkler, Stephen J. Kirin, and John S. Uebersax, 1992.

N-3527-A, *The Army Military Occupational Specialty Database*, Stephen J. Kirin and John D. Winkler, 1992.

R-4224-A, *How to Estimate the Cost of Changes in Army Individual Skill Training*, Susan Way-Smith, 1993.

MR-118-A, *Distributed Training of Armor Officers*, John D. Winkler, Susan Way-Smith, Gary Moody, Hilary Farris, James P. Kahan, and Charles Donnell, 1993.

MR-119-A, *Device-Based Training of Armor Crewmen*, Gary Moody, Susan Way-Smith, Hilary Farris, John D. Winkler, James P. Kahan, and Charles Donnell, 1993.

MR-120-A, *Computer-Based Training of Cannon Fire Direction Specialists*, Hilary Farris, William L. Spencer, John D. Winkler, and James P. Kahan, 1993.

The results should be of interest to policymakers concerned with military education and training and to managers responsible for designing and implementing training programs for specific military specialties. This briefing was prepared in the Arroyo Center's Manpower and Training Program, with additional support from RAND's Corporate Research Manager for Human and Material Resource Policy. The research summarized here was conducted by the Arroyo Center and the National Defense Research Institute, which are federally funded research and

development centers sponsored respectively by the United States Army and by the Office of the Secretary of Defense, the Joint Staff, and the defense agencies.

SUMMARY

INTRODUCTION

Individual training, which prepares soldiers to perform a military occupation and which occurs in classrooms, on job sites, and through self-development, is a large and costly part of Army operations. It requires an extensive training base—involving 83,000 trainee man-years at 68 Army schools—and it is multifaceted—involving over 300 entry-level occupations and advanced training courses, many of which are high in technical complexity.

Individual training also carries a big price tag, entailing roughly 10 percent (\$6 billion) of the Army budget in recent years. Its large size makes individual training a tempting target for budget reductions as the Army downsizes and seeks to maintain its combat power. As a result, the Army must confront the question of how it can reduce training costs while preserving effectiveness.

The Army has proposed a number of measures to reduce costs, which follow two general approaches: (1) shift training from schoolhouses to job sites, which can be accomplished by shortening or consolidating formal courses and by expanding on-the-job training (OJT) and self-development activities in units; and (2) use training technologies—e.g., training aids, devices, simulators, and simulations (TADSS)—more extensively in school or at soldiers' units and home stations through "distance learning" technologies.

Because these changes could have far-reaching effects on training costs and soldier proficiency, they need to be thoroughly assessed. The Army asked the Arroyo Center to develop and apply research methods to identify the Army training programs in which these new training approaches could be implemented and to assess their cost and effectiveness.

A SYSTEMATIC METHODOLOGY

Arroyo Center researchers developed a four-step research method that provides tools and analyses that, if applied sequentially and systematically, constitute an integrated method for evaluating training

approaches: (1) match occupations to training approaches; (2) develop alternative courses based on job requirements; (3) assess costs and savings of alternative courses; and (4) conduct "clinical trials" or experiments to confirm effectiveness.

Several RAND studies applied this methodology in a variety of occupations and training courses, covering officers and enlisted, combat and civilian-like, high-tech and low-tech, over such areas as armor, artillery, communications, and maintenance. These were generally selected as test cases from which results could reasonably generalize to other occupations and training courses.

FINDINGS

Shifting Training from School to Work Settings

Army techniques for designing training programs to support job requirements work fairly well, as seen in three courses—the Army Officer Advanced Course (AOAC), the introductory course for enlisted tank crewmen, and the introductory course for artillery fire direction specialists. Across the three courses, most material needed to perform the job, requiring training in school, was trained in school; very little material could be omitted as "unnecessary"; and only a limited amount of material could be shifted to units (less than was estimated under the Army's distributed training plan).

The AOAC showed the most potential for shifting material to units (25 percent, around four weeks of instruction). The analysis examined the effects of shifting this material to units by having the armor officers engage in "self-study" using media like computer-based training (CBT), videotape, and traditional paper products before they attended the AOAC. Results showed that costs and savings depend on the capacity of the units to absorb the additional training—that is, for example, whether courseware and equipment already exist, whether facilities like post learning centers are adequate, and whether additional manpower would be needed to oversee the training. If one assumes the units can absorb this training—the assumption initially favored by TRADOC—the shift can lower training costs. For a one-time cost of \$1.7 million, savings would accrue quickly, totaling \$8 million by the end of a five-year period (a breakeven point of one year).

However, if one assumes—as the analysis seems to indicate—that additional manpower and new equipment would be needed, that learning centers would need to be remodeled, and that there would be other costs

for development and support, the initial start-up costs would increase (from \$1.7 to \$7.2 million). At the same time, the recurring savings would decrease considerably (from \$8 million in five years to only \$4 million). The breakeven point would therefore go from one year to nine years.

In addition, the payoff is sensitive to the mix of media used to deliver the training. The above analysis used a mixture of CBT, paper, and videotape. However, using a more high-tech mix that included teletraining and other media turned out to cost more each year to operate than current training under any set of assumptions. In general, as distance learning media become more complex—including both hardware requirements and the range, quality, and fidelity of the courseware—the one-time start-up costs increase, while the recurring savings decrease.

Expanding the Use of Training Technologies

In looking at alternative uses of resources to train in the schoolhouse, we find that use of TADSS can be expanded in many courses. The Abrams armor crewman course provides a good example. While the current course uses training technology (a driver simulator) for only 11 percent of its current course hours, an alternative course could decrease the use of tanks from 59 percent to 20 percent. It would do this by increasing the 11 percent use of training technology to 59 percent by using such training devices as turret trainers and hull driver trainer vehicles.

Although analysis showed that such technology applications could reduce costs, the amount depends on how the training devices are obtained. If they are built from scratch—say, developed by a defense contractor—start-up costs of \$20 million would return \$16 million in the initial five-year period, with breakeven in approximately six years. Given the lifecycle of the Abrams tank, this is probably a worthwhile investment. But if the devices are adapted from existing tanks, by converting the tanks in inventory at Fort Knox into turret trainers and hull driver vehicles, start-up costs of \$8 million would return \$38 million in savings in five years, with breakeven in around two years. These savings accrue because the school would no longer need to operate and maintain the converted tanks.

While using training devices can save money—as shown above—the effectiveness of those training devices depends on how they are used. Because the training technologies for the armor crewmen have not been built yet, the effectiveness of the technologies could not be assessed; however, another series of studies did examine this issue in two communications courses at the Army Signal School. The studies involved experiments that used random assignment of students, monitoring of

training, and hands-on performance tests. They were designed to test two contrasting strategies for using training technology: (1) *enhance* training by adding technologies to existing resources; and (2) *substitute* for hands-on training in a resource mix, as in the armor crewman example.

In the enhancement experiment, student performance did not improve significantly. Researchers created an experimental classroom in a multichannel communications equipment operator course and provided interactive videodiscs (IVDs) to enhance the training. In the control classroom, training was done exclusively on multichannel radio sets. The IVD program was fully accepted and implemented in the experimental classroom, and it did increase practice time by 45 percent within the same course length. However, enhancement produced no significant improvement, primarily because initial proficiency was already high.

In the substitution experiment, IVDs were used in place of more expensive tropospheric scatter radios in a tactical satellite/microwave systems operator course. In this case, despite the resource substitution, the students received roughly equivalent training in the two classrooms. And, more important, students from the two classrooms were equally able to perform the required tasks to Army standard. At the same time, the experimental classroom cost one-fifth as much as the control classroom in terms of equipment costs and one-half as much in instructor costs, since running the experimental classroom required less over-the-shoulder supervision.

ARMY USES OF RESEARCH

Based on the analysis discussed here, as well as on a series of other studies, the researchers recommended how to restructure courses, invest in technology, and use training resources most effectively. The Army adopted a number of the specific policy recommendations and is planning to convert tanks to training devices as recommended, has dropped plans for teletraining equipment totaling \$180 million, and has restructured training courses along the lines recommended in the studies.

In addition, the Army adapted and implemented several of the methodologies used in the research. Specifically, the approach for reviewing occupations' job requirements and current training approaches has been incorporated as part of a new Army occupational training system, and the methodology developed for analyzing training resources and costs has been incorporated in Army professional education courses for training developers and managers.

GENERAL LESSONS LEARNED

First, the research showed the need to ensure *proper alignment between school and work* by setting skill standards and measuring job performance, and by using job performance data to develop and revise curricula. Second, the research revealed the need to *develop an investment plan* for training technology, one that emphasizes existing technologies (adapted as needed), one that adds resources only where performance is deficient, and one that substitutes technology in place of more expensive training resources. Finally, the research confirmed *the value of field trials and tests* of new training methods, which provide direct evidence of the costs and effectiveness of new training approaches.

Some of these lessons also apply to civilian education and training. Although the two systems differ across a number of dimensions, the lessons may transfer, especially in technical fields. Specifically, the military experience with occupational skills standards and performance measures for comparable jobs, instructional design methods for aligning training with work, and educational courseware and simulations may be applicable to civilian settings. More important, the military experience shows the need and the value of attending carefully to costs and benefits and in conducting systematic assessments of education and training innovations.

Improving Training at School and Work:

Lessons from RAND Research on Army Individual Training

This briefing summarizes lessons from research on military education and training, conducted over several years in two of RAND's federally funded research and development centers—the Arroyo Center and the National Defense Research Institute.

The primary focus of this research has been on individual skill training, which prepares soldiers to perform duties of a military occupation. Much of this training is done in classrooms at U.S. Army schools, but some of it is carried out on job sites (e.g., in tactical units such as divisions) and through self-development (e.g., by self-study using correspondence courses and audiovisual materials).

This document synthesizes the findings of this research and draws general conclusions and policy implications for training in the military. It also highlights findings that are relevant to current policy debates in civilian education and training.

The Army Education and Training System Is Large and Costly—and Must Come Down

- **Extensive**—83,000 trainee man-years at 68 Army schools
- **Multifaceted**—300+ occupations, 85% with civilian counterparts
- **Expensive**—\$6 billion (nearly 10% of Army budget)

Problem: How to reduce costs but preserve effectiveness

Individual training in the Army is a big enterprise. First, the training base is extensive. The portion conducted in Army schools involves large numbers of personnel and large quantities of facilities, installations, equipment, and consumables. Second, the training is multifaceted, involving a range of occupations and training courses (over 300 entry-level occupations and advanced training courses). Many of these occupations are high in technical complexity (e.g., jobs in electronics, health care, and repair/maintenance). In addition, much of the skill base is common to the civilian sector—85 percent of occupations have a direct civilian counterpart in the U.S. Department of Labor's Dictionary of Occupational Titles (e.g., maintenance, construction).

This training also has a high price tag: roughly \$6 billion, around 10 percent of the Army budget. This amount provides a tempting target for budget reductions as the military downsizes and seeks to maintain its combat power.

Thus, a key question confronting the Army is: How can it reduce the costs of training while preserving training effectiveness?

Army Efforts to Cut Costs and Preserve Effectiveness Follow Two Approaches

Shifting training from school to work settings

- Shorten courses and reduce instructor manpower
- Consolidate occupations and courses
- Increase self-development and OJT in units

Expanding use of training technologies

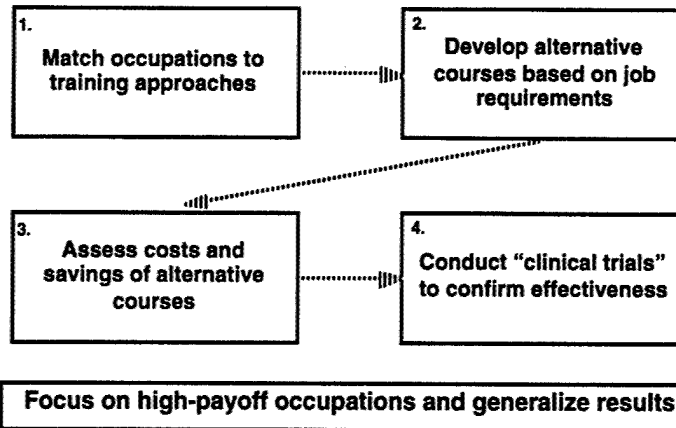
- Conduct computer-supported simulations
- Use "distance learning" technologies in work settings

The Army has proposed a number of measures to reduce training costs, which follow two general approaches.

- *Shift training from schoolhouses to job sites.* This can be accomplished by shortening or consolidating formal courses, and expanding on-the-job training (OJT) and self-development activities in units.
- *Use training technologies, e.g., training aids, devices, simulators, and simulations (TADSS).* These may be used more extensively in school or at soldiers' units and home stations through "distance learning" technologies.

The Army asked the Arroyo Center to develop and apply research methods to flesh out such training approaches, determine how they would be implemented in practice, and assess their costs and effectiveness.

We Developed Systematic Methods to Screen and Evaluate Training Approaches



Our research provided tools and analyses that, if applied sequentially and systematically, constitute an integrated method for evaluating training approaches. There are four steps.

1. Analyze all Army occupations, determine where costs could be lowered significantly through new training approaches, and select ones with high-payoff potential. An example of this involves finding the occupations where it makes most sense to shift training to units or to expand use of training technologies.
2. For specific occupations, collect and analyze job performance measures (what soldiers actually do), and compare job and training requirements to current curriculum. Then, design alternative courses that change training content and methods in ways that preserve training effectiveness. An example of this involves identifying how much material is really suitable for training in units and laying out curricula and technologies to support it.
3. Analyze resources and costs of changing training approaches using an "activity-based costing" method. This method examines major functions of training development, training delivery, and training support; determines changes in resources and activities needed to change training; and assigns cost factors to the resource changes. It

also determines one-time start-up costs, annual recurring costs and savings, and the time to break even.

4. Take the alternatives that promise to save costs, and if there are doubts that the new approach will preserve training effectiveness, conduct randomized clinical trials comparing effects of alternative training approaches on soldier performance.

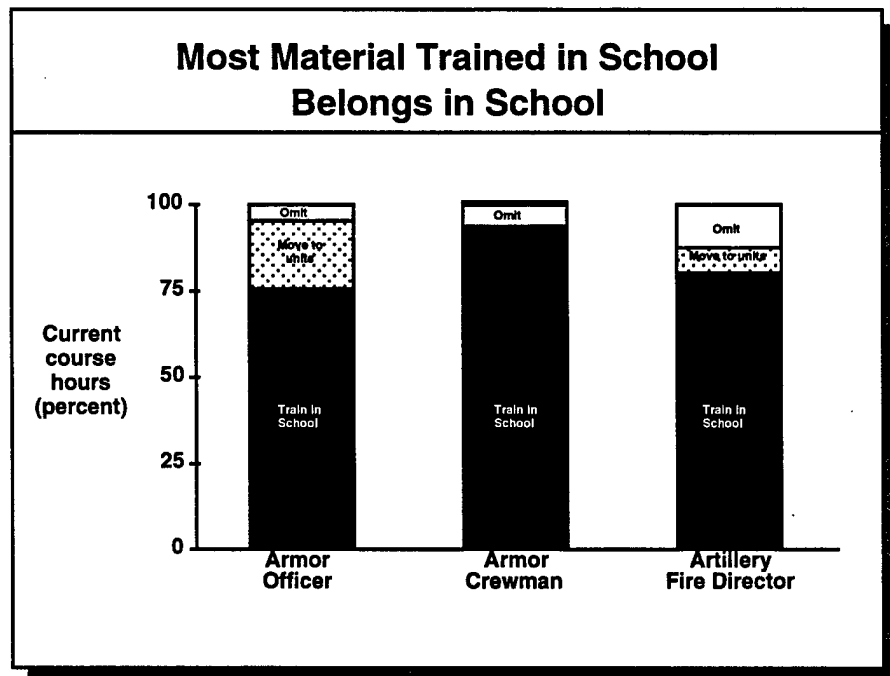
Our research applied elements of this methodology in a number of occupations and training courses, covering officers and enlisted, combat and civilian-like, high-tech and low-tech, over such areas as armor, artillery, communications, and maintenance. These were generally selected as test cases from which results could reasonably generalize to other occupations and training courses.

Research Issues and Findings	
Issues	Findings
Shifting training from school to work settings	<ul style="list-style-type: none"> • School training is generally well aligned with job needs • Major shifts to units can raise costs • Costs and savings depend on need for new infrastructure and delivery method
Expanding use of training technologies	

As mentioned earlier, one general approach for cutting training costs and preserving effectiveness is shifting training from the school setting to the work setting by increasing the amount of self-development or OJT.

In a number of studies exploring the potential for shrinking the schoolhouse and expanding training in units, we found:

- Army techniques for designing training programs to support job requirements work fairly well;
- Attempts to shift the training to units will often *not* produce the desired outcome, that is, lower the costs of training;
- The amount of costs and savings depends on the need for new infrastructure to support training in units and the way the training is delivered in units.



The Army pioneered the development of instructional design methods, in particular the systems approach to training, which sets skill standards for occupationals and devises curriculum to provide the necessary knowledge, skills, and abilities in school and on the job. Our analysis comparing job requirements to current training approaches found, in general, a good alignment between school and work in the training courses we examined.

We examined this issue in three courses: the armor officer advanced course (AOAC), which prepares armor captains to be company commanders; the introductory course for enlisted tank crewmen; and the introductory course for artillery fire direction specialists, who receive target data from forward observers, compute angle and direction of fire, and communicate the solution to the artillery batteries.

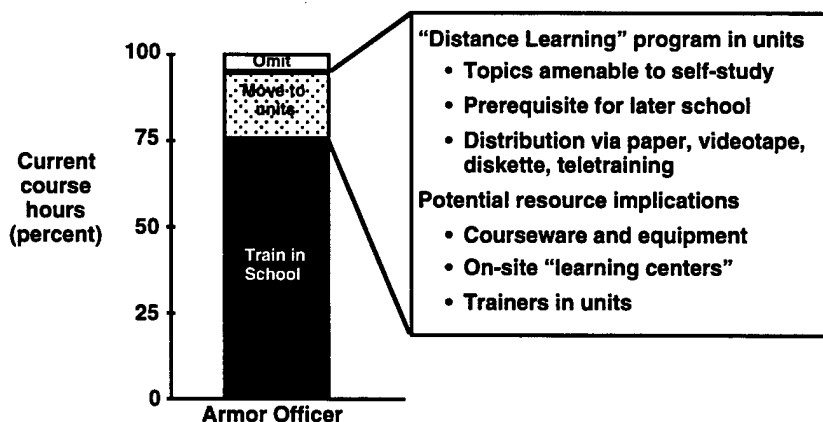
The above graph shows how much of *current schoolhouse training* our "job analysis" indicated was "proper" for training in school.

- Most material needed to perform the job, requiring training in school, was trained in school—75 to 93 percent of *current course hours* in these cases.

- Only rarely was “unnecessary” training found that could be omitted (i.e., training on tasks that wouldn’t actually be performed in the subsequent job).
- Some material could be shifted to units, but not a lot. The best example was in the AOAC. But even here, only 25 percent of the current course material was found to be amenable for a shift, which was less than had been estimated under the Army’s plan for distributed training.

Thus, the potential is limited for shifting training from schools and into units—at least in terms of the quantity of material amenable to such a shift.

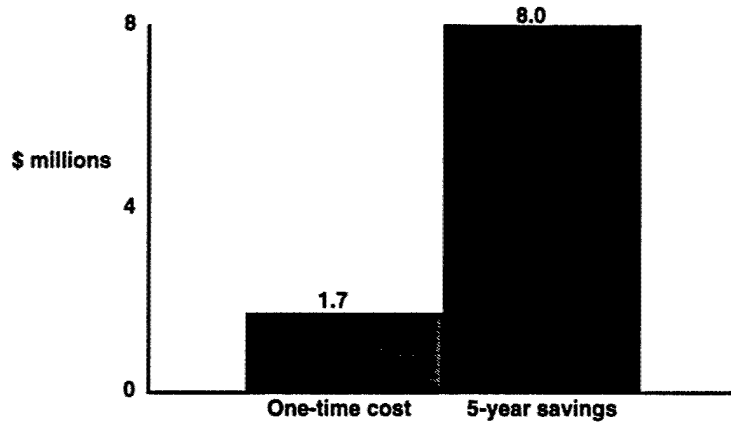
Shifting Training to Units Requires Changes in Training Strategy and Resources



What happens when attempts are made to move training out of school and into units where there is some potential for doing so? This example comes from our analysis of "distance learning" for armor officers. Here we examined the effects of moving four weeks of training from the school to the unit by having officers engage in "self-study" prior to attending the armor officer advanced course. This training would be supported with media like computer-based training, teletraining, and traditional paper products.

Our research found that the costs and savings of this program depend on the capacity of units to absorb this additional training, that is, whether courseware and equipment already exist, whether facilities like post learning centers are adequate, whether additional manpower would be needed to oversee the training, and so forth.

Shifting Training to Units Appears to Pay Off If Unit Resources Are Adequate



If one were willing to assume that units had the capacity to absorb this training—the assumption initially favored by the Army's Training and Doctrine Command—then shifting training to self-study in units could lower training costs. The graph above shows RAND's analysis of costs and savings under this assumption. For a one-time cost of \$1.7 million, savings would accrue quickly, totaling \$8.0 million by the end of a five-year period. This represents a breakeven point of about one year.

Cost and Savings Depend on Whether New Infrastructure Is Needed

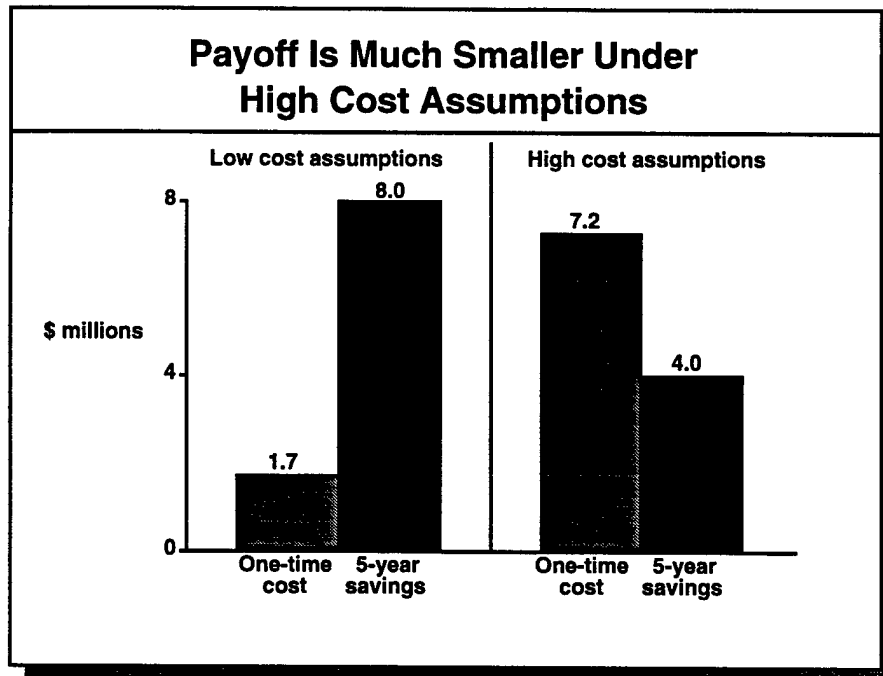
Training Functions	Resources/ Activities	Assumptions	
		Low Cost	High Cost
Delivery	Facilities and equipment	No new	New/remodel
	Manpower	No new	Additional
	Training time	Off duty	On duty
Development	Product development	Fixed cost	Hourly rates
Support	Logistics and Maintenance	Low	High

But as indicated, this analysis assumes this new training to be within the capacity of units to deliver. Thus, they are “low cost” assumptions because they require no new investments in infrastructure.

There is a contrasting set of assumptions, which we term “high cost” assumptions. The above table shows the difference between the “low cost” and “high cost” assumptions used in our analysis.

- The major training functions examined in our cost analysis are shown on the left—delivering training, developing training products, and “overhead” support for the training.
- Next are the major resources and activities included in each of these functions (e.g., delivering training requires facilities, equipment, people, and time to conduct it, products to support it, and ongoing distribution and maintenance).
- The final two columns show how these resources and activities are treated under the “low cost” and “high cost” assumptions. The assumptions about costs of training delivery are the most important. In contrast to the low cost assumptions, the high cost assumptions state that the program would need additional manpower to support training in units, new equipment to support the training, remodeled facilities

(such as learning centers) to hold additional training material, and other activities (e.g., for development and support).



Based on our analysis, we believed the “high cost” assumptions were more likely. Our analyses showed that if the high-cost assumptions were correct, the initial start-up costs would increase, while the recurring savings would decrease considerably.

- The left panel in the above graph shows the cost results under the low cost assumptions from earlier. The right panel shows how the cost results change under the high cost assumptions.
- Now, instead of returning \$8 million on a \$1.7 million investment, it would take an investment of \$7.2 million to get \$4 million back in five years.
- The breakeven point goes from one year to about nine, which is not nearly as good an economic proposition.

All in all, this analysis shows that shifting training from the schoolhouse to self-study in units won’t necessarily produce the desired outcome, lowering the costs of training. If you believe the higher cost assumptions, a large up-front investment is required that will not pay off for a long time—perhaps longer than the currency of the material the new training is designed to deliver.

Payoff Is Sensitive to Training Delivery Methods

- **Compared three media mixes for delivering training**
 - **Computer-based training, with paper and videotape**
 - **Teletraining plus other media**
 - **100% paper**
- **Teletraining does not pay off for this course**
 - **Large start-up costs**
 - **Yearly operating costs exceed those of current course**

There is a further wrinkle to these findings—the amount of costs and savings is also sensitive to the mix of media used to deliver the training. The previous analysis used the first set of media shown on the above chart, a mixture of computer-based training (CBT), paper, and videotape. We examined two additional alternatives—a more complex, “high tech” mix that included videoteletraining, and a less complex, “low tech” mix that included only paper (e.g., reading material, worksheets, and so forth).

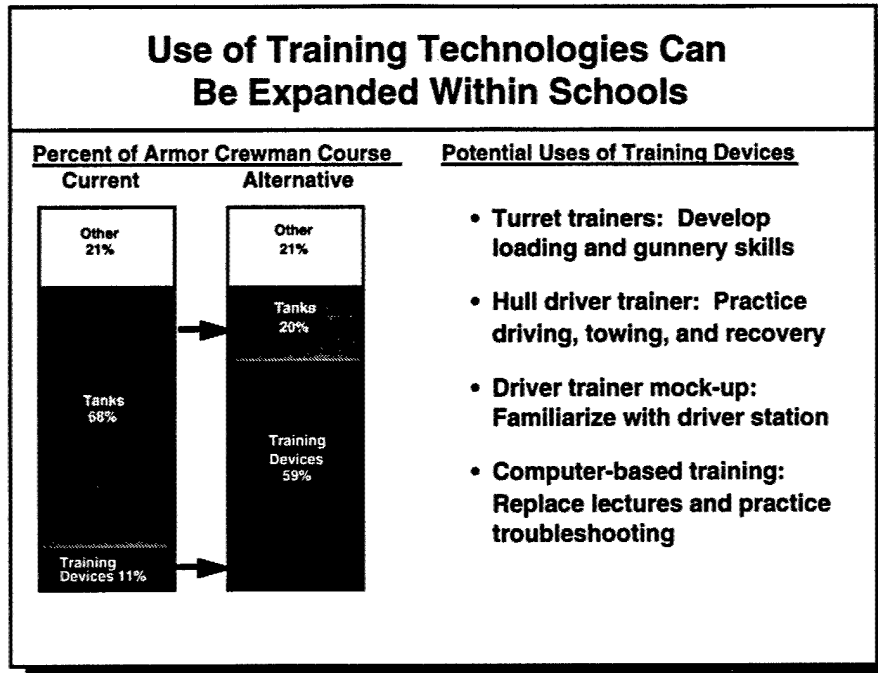
The analyses showed that some media can actually increase the costs of the training, compared to current methods. For example, using teletraining to support training in units would cost more each year to operate than current training—*under any set of assumptions*. The recurring costs increase because as the media become more complex, operation and maintenance costs increase.

In general, as distance learning media become more complex, the one-time, start-up costs increase, while the recurring savings decrease.

Research Issues and Findings	
Issues	Findings
Shifting training from school to work settings	
Expanding use of training technologies	<ul style="list-style-type: none"> • Considerable room to increase use of technology in schools • Most savings obtained by adapting existing resources • Technology should be used to replace, not enhance, hands-on training

The second set of findings addresses whether expanding the use of training technologies can reduce costs but preserve effectiveness. Our findings show:

- There is room to expand the use of technology to deliver training in schools, and doing so can lower the costs of training;
- From the cost perspective, it is better to adapt existing technologies, using material that is already on hand or available off-the-shelf, rather than build new technologies from scratch;
- The effectiveness of training technology *depends on how it is used*—that is, there is a bigger payoff from using technology as a substitute for more costly training methods than there is to “enrich” training—the more common use of training technology.



Our methodology for analyzing and developing alternatives to current training courses was also used to examine alternative uses of resources to train in the schoolhouse. The aim was to determine where use of TADSS could be feasible. From this, we found that there was considerable room to expand the use of training technologies within schools.

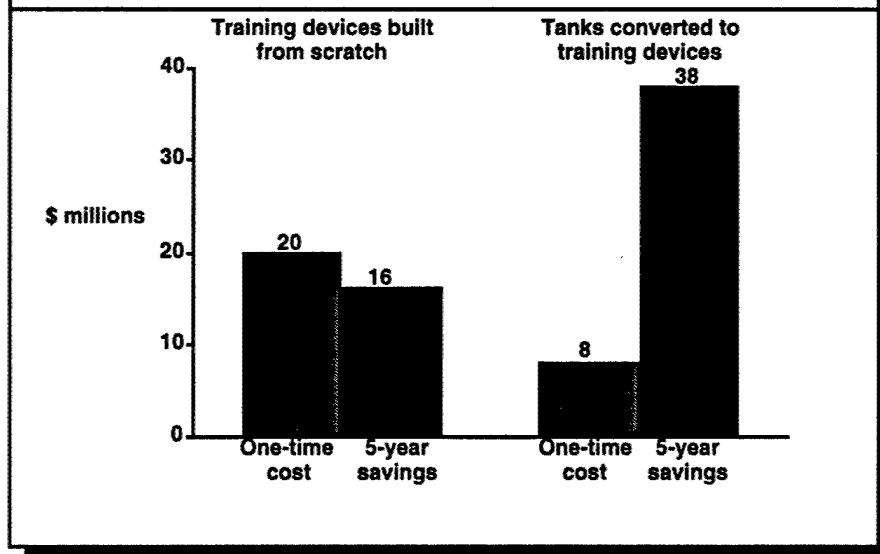
This analysis used principles of instructional systems design to suggest candidates for training technology. The method matches tasks to technologies and suggests alternatives, considering criteria like skill requirements, need for instructor supervision, and equipment cost.

We did this in a number of courses, but we illustrate the approach with the example of the Abrams armor crewman course, which trains a new enlisted soldier to serve as a tank crewman. When we examined this course, we found *many of the tasks now trained using tanks could be trained using training devices*. The left bar in the above figure shows the current course, in which there is minimal use of training technology—in this case, a driver simulator for 11 percent of current course hours. The right bar shows an alternative, in which the use of tanks decreases from 68 percent to 20 percent of current course hours, while the use of training devices and simulators increases from 11 percent to 59 percent of current course hours.

Note that the training technologies do not *replace* the tank entirely; instead, their relative usage changes. For example, the analysis examines the use

of turret trainers to learn and practice procedures performed by the loader, gunner, and so forth.

But Savings Depend on How Training Devices Are Obtained



Our cost analysis showed that use of training technologies in this fashion could reduce costs, but the amount of costs and savings depended on how the devices were obtained (as shown in the above figure). If they were built from scratch—say acquired from a defense contractor—we estimated that start-up costs of \$20 million would return \$16 million in the initial five-year period. The payback period is approximately six years. Given the lifecycle of the Abrams tank, this is probably a worthwhile investment.

But if the devices are adapted from existing tanks, by converting the tanks in inventory at Fort Knox into turret trainers and hull driver trainer vehicles, start-up costs of \$8 million would return \$38 million in savings in five years, representing savings in tank operating costs and maintenance. This program would take two years to break even.

Incidentally, converting tanks to training devices is not as radical an idea as it may appear. This was done with the earlier-generation M60 tanks.

Clinical Trials Examined Effects of Technology on Proficiency

- **Experiments conducted in communications courses**
 - **Multichannel communications equipment**
 - **Tactical satellite/microwave systems**
- **Experiments used random assignment, monitoring of training, and hands-on performance tests**
- **Contrasting strategies tested in two experiments**
 - ***Enhance* training opportunity**
 - ***Substitute* for more expensive hands-on training**

The cost analysis of armor training devices shows that use of training devices can save money. The question then is how effective they will be. Clinical trials comparing technology-based training to current methods of training are needed to answer this question.

We were not able to assess the effectiveness of training technologies for the armor crewman (because they have not yet been built), but we did examine this in another series of studies conducted in Army training classrooms. These studies showed that the effectiveness of training technologies *depends on how they are used*.

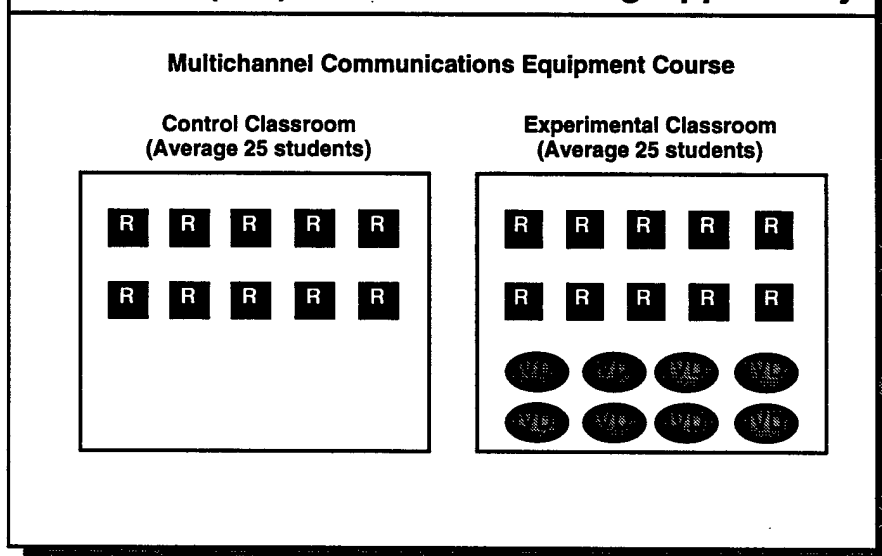
The experiments were conducted in communications courses at the Army Signal school, in initial training courses for two "high-tech" occupations: the multichannel communications equipment operator course, and the tactical satellite/microwave systems operator course.

The experiments employed classical principles: random assignment of students to control and experimental classrooms, measurement of training received under alternative training methods, and measurement of student performance using hands-on tests.

These studies examined two contrasting strategies for using training technology. One is to *enhance* training by adding technologies to existing

resources. The other is to *substitute* for hands-on training in a resource mix, as in the armor crewman example.

Enhancement Experiment: Using Interactive Videodisc (IVD) to Increase Training Opportunity



The above chart illustrates how we conducted the enhancement experiment. The "control" classroom is the current situation. The classroom contains ten multichannel radio sets and serves 25 students. There is an appearance of inefficiency because 10 students can train on the radios while the remainder work at desks waiting for a hands-on training opportunity.

Signal school personnel had the idea that they could increase practice opportunities by obtaining and developing simulations on interactive videodisc (IVD). IVD combines computer-assisted instruction on a PC with visual images from a videodisc. Here it was used to simulate the procedures for operating the radio. The trainee uses a touch pen to place cables where they belong, set meters, and so forth.

The experiment tested this idea—enhance training opportunity by adding IVD simulations to the existing classroom. We persuaded the Signal school to set up side-by-side classrooms that looked like this and to randomly assign students to one or the other for training. We later measured the students' performance using hands-on tests.

Over 200 students participated in this experiment.

Results of Enhancement Experiment

- **IVD program was fully accepted and implemented in classrooms**
- **Practice time increased by 45% within same course length**
- **But enhancement produced no significant improvement in performance**
 - **Performance was very high to begin with**

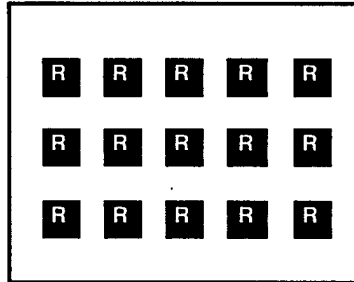
The results were a bit disappointing. The IVDs were well-accepted by instructors and students, and they were used to increase practice time. The IVD group received nearly half again as much training time as the control group. But performance did not improve that much. In a later test of performance, the IVD group was able to complete the task faster, with less effort and fewer mistakes. But both groups were very proficient at meeting the military standard: 96 percent of the trainees eventually got the task right in the allotted time. Proficiency seemed adequate to begin with.

It seems that initial proficiency should have been taken into account before adding resources to classrooms. Even though there were only 10 radios and 25 students, practice time was adequate.

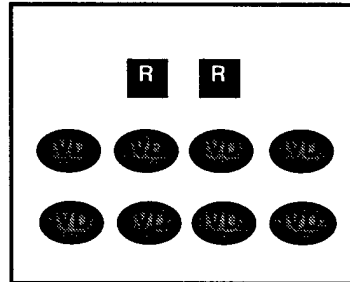
Substitution Experiment: Using IVD in Place of More Expensive Equipment

Tactical Satellite/Microwave Systems Course

Control Classroom



Experimental Classroom



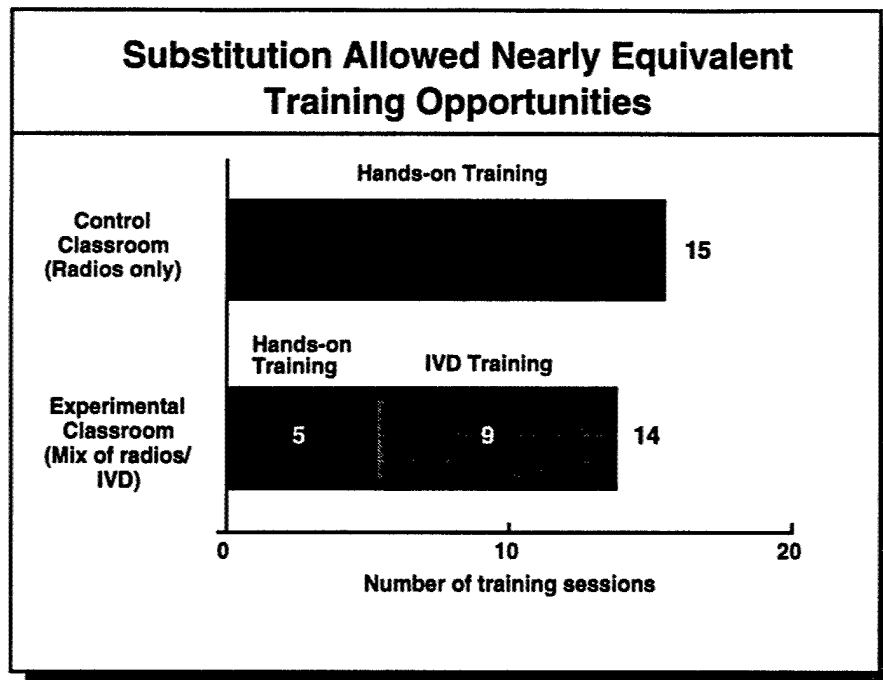
Cost of equipment is five times greater in control classroom

This experience led us to recommend another strategy for using training technology—to reduce training costs and *preserve* effectiveness by substituting technology for hands-on training where technology was cheaper. We proposed another experiment to the Signal school, which changed the *mix* of resources used to train by substituting IVDs for some (but not all) of the radios.

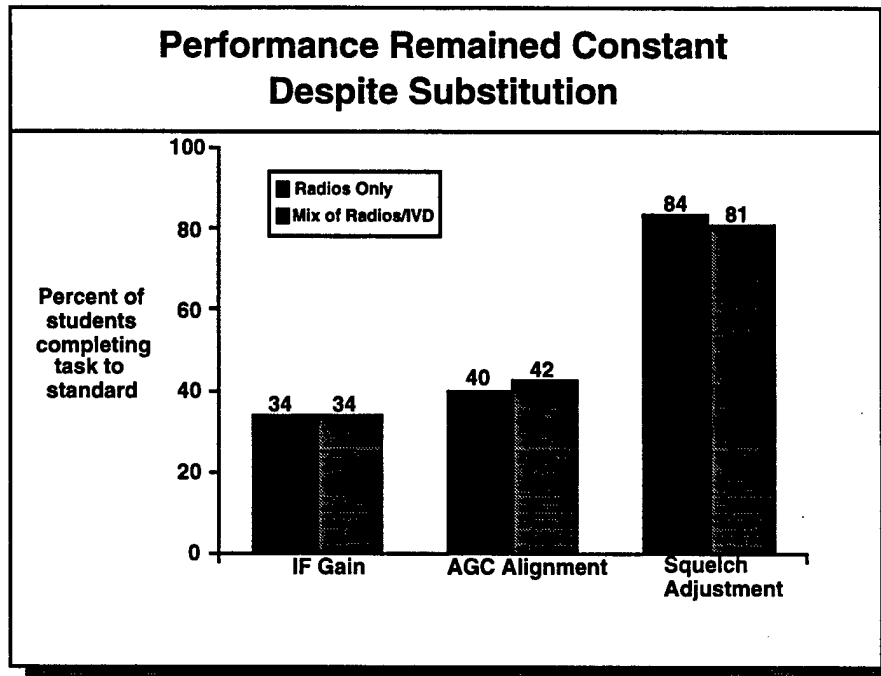
The experiment is illustrated in the chart above. We again set up side-by-side classrooms, this time in a different training course. The “control” group trained in the standard method, using a room full of tropospheric scatter radios. The experimental group used only a couple of radios, relying mostly on IVD simulations.

The notable feature here is that the experimental classroom is much less costly than the control classroom—by a factor of five in the costs of the radio versus the radio/IVD mixture. It also turned out that running the radio/IVD classroom required fewer instructors, by a factor of two, since less over-the-shoulder supervision was needed to use the radio/IVD mix.

Over 200 students participated in this experiment.



Despite the resource substitution, the students received roughly equivalent training in the two conditions. The above graph shows the number of “practice sessions” received by the students in the two classrooms. Each practice session covered a number of procedures needed to install and operate tropospheric scatter radios. Students in the control classroom received about 15 sessions in which to practice the tasks. Students in the experimental classroom received 14 sessions on average in which to practice the task, 9 of which occurred on IVD.



The above graph shows how the students in the two conditions performed on hands-on tests of several tasks covered in the practice sessions using radios or the radio/IVD mixture.

The two groups were statistically indistinguishable. Both groups were equally able to perform the tasks to Army standard. Performance was not all that high in all cases, but it did not matter whether the students were trained using equipment or a mix of equipment and simulation.

Army Uses of RAND Research	
Policy changes	<ul style="list-style-type: none"> • Army plans to develop tank training devices per RAND recommendations • Army cancelled \$180 million budget item for teletraining equipment • Training courses restructured along lines recommended by RAND
New methods adopted	<ul style="list-style-type: none"> • Approach for overhauling training courses • Method for costing training changes • Technique for setting funding priorities for interactive courseware

Collectively, the above studies have made a number of specific recommendations about how to restructure courses, invest in technology, and use training resources most effectively.

The Army has adopted a number of our specific recommendations.

- The Army plans to convert tanks to tank training devices.
- The Army dropped from budget planning documents an item for teletraining equipment totaling \$180 million.
- Specific courses, like the artillery fire direction specialist and others, were restructured based on RAND research results.

In addition, the Army has adapted and implemented several of our methodologies.

- The approach for examining occupations and reviewing job requirements and current training approaches has been incorporated as part of a new Army occupational training system.
- The methodology developed for analyzing training resources and costs has been incorporated in Army professional education courses for training developers and managers.

- Criteria establishing appropriate uses of training technology, drawn from our work, were used to set priorities for allocating funding for IVD courseware development.

Lessons from These Studies

- **Ensure *proper alignment between school and work***
 - Set skill standards and measure job performance
 - Use job performance data to develop and revise curricula
- **Develop an *investment plan* for training technology**
 - Emphasize existing technologies, adapted as needed
 - Add resources only where performance is deficient
 - Substitute technology in place of more expensive training resources
- **Experiment and monitor new approaches**
 - Assess training outcomes and payoffs
 - Verify cost parameters and assumptions

We have also drawn some general lessons from our Army training research.

First, the research has shown the value in the Army's approach to designing instructional systems. The system is particularly strong at identifying occupational skill standards and "translating" them into a curriculum that meets job skill requirements.

But to the extent that the system could be strengthened, it is in the area of routine monitoring and feedback. Hence, we have also learned that to keep training in alignment with job requirements, it is necessary to collect data on work performed on the job and to feed this information back on a routine basis to ensure that training remains current with job requirements and uses the most efficient resources.

Second, we have emphasized the need for a systematic, coordinated investment plan for technology. The plan should seek, as much as possible, to use on-hand and off-the-shelf technologies, such as videotapes and CBT on personal computers, instead of one-of-a-kind, complex systems. This is not to preclude some expensive technologies, but it establishes priorities where performance needs improvement, while seeking to maximize the use of technology to improve efficiency and reduce costs.

Finally, we have observed the value of field trials and tests of new training methods, which provide direct evidence of the costs and effectiveness of new training approaches.

How Applicable Are These Lessons for Civilian Education and Training?

- **Civilian education/training system different from military**
 - Employers and educators not as well connected
 - Serves broader population with wider needs
 - Key problem is to increase effectiveness
- **But lessons may transfer, especially in technical fields**
 - Occupational skills standards and performance measures for comparable jobs
 - Instructional design methods for aligning training with work
 - Experience with educational courseware and simulations

Key need: Rigorous assessments of benefits and costs

The above research findings and lessons have been developed from research on Army training courses. We feel, however, that insights of these studies could help civilian education and training institutions improve the preparation of citizens for work.

Obviously, there are differences between the military and the civilian education and training system. The military is a "closed system" in which employers and educators belong to the same organization. Military personnel are a select group, nearly all with high school diplomas, most scoring high on aptitude tests for the jobs in which they are trained. They are volunteers with high motivation to learn the job and a contractual obligation to do so. The civilian world is different, with employers and educators often at loggerheads, and there is more variability in educational objectives and populations served.

Moreover, where the military's problem is to reduce the costs of training while preserving its effectiveness, the problem in civilian settings is often that of *increasing* effectiveness within available resources.

Despite these differences, we think there are enough essential points of similarity to permit leveraging the military experience for civilian purposes. First, the military experience emphasizes the importance of having occupational skills standards and measures of performance that establish what people need to know to perform effectively on the job.

Indeed, many existing military skill standards and performance measures may transfer to similar civilian jobs.

Second, the military experience also demonstrates the importance of systematically and routinely linking the standards to curriculum. Principles of the military's instructional design methods might usefully be applied in civilian settings.

Third, the military experience points to the need for a hard-nosed, practical approach to developing technology and applying resources in support of that. Military experience with educational technology (hardware and courseware) and its applications (e.g., for simulation) is informative.

Finally, and perhaps most important, the military experience shows the need and the value of attending carefully to costs and benefits and of conducting systematic assessments of education and training innovations.